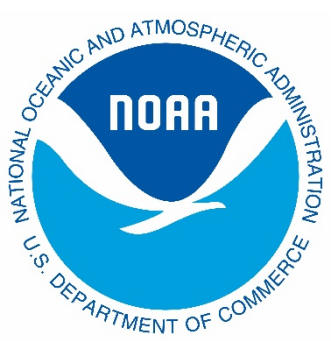
ABSTRACTS

2019 NMFS – Sea Grant Graduate Fellows Symposium



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Sabrina Beyer

University of California Santa Cruz
Advisors: Suzanne H. Alonzo, Marc Mangel
NMFS Mentors: Susan M. Sogard, John C. Field
Population and Ecosystem Dynamics, 2018

Oceanographic effects on plasticity in rockfish (*Sebastes* spp.) reproductive success and consequences for population dynamics

Sabrina Beyer

Reproductive parameters, such as maturity and fecundity, used in models to assess the health and status of fish populations are generally treated as static through time. However, growing evidence suggests that changes in the ocean environment and a history of exploitation drive variability in life history traits. Often, little is known about how fecundity and population productivity respond to environmental change. Here, I propose both empirical and theoretical methods to understand plasticity in reproductive output among economically important rockfishes (*Sebastes* spp.) in the California Current Ecosystem (CCE). First, I present results of a laboratory study documenting reproductive plasticity in Rosy Rockfish (*S. rosaceus*) in response to manipulations of water temperature and food availability. Second, I propose developing a state-dependent model to predict optimal female reproductive output in relation to the environment. The individual model will be imbedded into a population model to simulate the effects of short- and long-term oceanographic change predicted for the CCE on rockfish reproductive success. My research will improve understanding of spatiotemporal variability in reproductive success and estimates of larval production for stock assessments.

Erin Bohaboy

University of Florida
Advisor: William F. Patterson III
NMFS Mentor: Shannon L. Cass-Calay
Population and Ecosystem Dynamics, 2016

Harvest Slots as a Management Tool to Maximize Marine Recreational Fishing Opportunities and Sustainability: Gulf of Mexico Red Snapper as a Model Species

Erin Bohaboy, William F. Patterson III

The Gulf of Mexico (GOM) red snapper (*Lutjanus campechanus*) stock was depleted to historically low levels by the early 1990s and remains under a rebuilding plan despite years of stringent fishing regulations, such as daily bag limits, minimum size requirements, and seasonal closures in the recreational fishery and an individual fishing quota system in the commercial fishery. Studies of charter boat customers' discarding behaviors and attitudes as well as evidence that releasing red snapper using weighted return-to-depth (or descender devices) reduces discard mortality, suggest that harvest slots (a minimum and a maximum size regulation for harvested fish) could be a viable management tool for this valuable fishery. Two different model simulation approaches were used to examine the effects of slot limit regulations and discard mortality rates on GOM red snapper: 1) equilibrium age-structured yield per recruit, and 2) Stock Synthesis version 3.30. Recreational retention at length and discard mortality were modified to reflect combinations of slot limits (minimum length at retention = 16−20", maximum length at retention = 22−34" or no maximum length limit) and discard mortality (0−30%), assuming the stock was managed for a spawning biomass target. Results suggest slot limits would lead to some desirable outcomes, such as increasing the mean size of fish in the catch and allowing for longer fishing seasons, but would come at the cost of decreased harvest and catch rates. Reducing discard mortality could amplify gains in catch, size of fish in the catch and stock, and season length, while also tempering losses to harvest and catch rates associated with greater regulatory discarding that would occur with slot limits. Although changes in catch, harvest, and season length were generally slight, a wide slot limit (e.g., 16−32") combined with reductions in discard mortality (25−50%) may result in sufficient improvements in recreational fishing opportunities to warrant consideration of this previously unused management tool for GOM red snapper.

Brian Bowen

Hawaii Institute of Marine Biology, University of Hawaii

The scientific field of conservation biology is dominated by three specialties: phylogenetics, ecology, and evolution. Under this triad, phylogenetics is oriented towards the past history of biodiversity, conserving the divergent branches in the tree of life. The ecological component is rooted in the present, maintaining the contemporary life support systems for biodiversity. Evolutionary conservation is concerned with preserving the raw materials for generating future biodiversity. Advances in all three domains can be documented with genetic case histories in the waters of the Hawai'i. This review includes cases that demonstrates 1) phylogenetic studies have identified previously unknown species that are endemic to Hawaiian waters; 2) population genetic surveys reveal management units as isolated marine ecosystems and islands, and 3) phylogeographic analyses illustrate the pathways of colonization into Hawai'i. Over the last three decades, genetic studies in Hawai'i have advanced all three domains in conservation biology, and recent genomic technologies are especially valuable for monitoring and managing the marine biodiversity of Hawai'i.

Reed Brodnik

University of Maryland
Advisor: Thomas Miller
NMFS Mentor: Kiersten Curti
Population and Ecosystem Dynamics, 2017

A simulation-estimation approach to quantify the consequences of assuming incorrect spatial population structure in stock assessment - Case study using the Mid-Atlantic Bight (Hatteras, NC - Cape Cod, MA) Black Sea Bass (*Centropristis striata*) stock

Reed Brodnik, Thomas Miller, Kiersten Curti

Stock assessments make assumptions about the spatial population structure of exploited marine fishes, but the consequences of assuming incorrect spatial structure are not well understood. Simulation-estimation approaches, in which simulated populations (operating models) specify the true underlying spatial structure while estimation models represent the spatial structure assumed in the assessment, provide a way to compare bias and precision of reference points generated by a suite of assessment models. Black Sea Bass (BSB, *Centropristis striata*) in the northwest Atlantic Ocean are representative of a broader set of exploited species for which management stands to benefit from understanding the consequences of incorrectly specifying spatial structure in assessment. For management purposes, BSB north of Cape Hatteras, NC are assumed to exist as two separate stocks with no mixing, as the degree of seasonal mixing among and between putative stocks is not known. We use a simulation-estimation approach for a population roughly based on the Mid-Atlantic Bight BSB stock (Hatteras, NC - Cape Cod, MA) in order to compare estimation models which assume a range of different spatial structures, focusing particularly on whether future investments should focus on resolving questions of spatial structure, or improving the quality of input data for the assessment.

Emily Cadiz
University of Hawaii at Mānoa

Pilana—Mālama—ʻĀina momona: **A Community-driven Monitoring Program to Understand Health and Well-being of People and Place in Hāʻena, Kauaʻi**

Emily Cadiz

Indigenous communities assess health and well-being holistically because they view people, place, and resources as interconnected. Contrary to this, centralized governance systems use monitoring tools of selected resources rather than connecting across to ecosystems and human well-being. In Hawaiʻi, there is a shift towards community-based fisheries management. However, communities are struggling to balance their ways of understanding resource health under the governing standards of scientific rigor, and monitoring expectations. Lack of integrative monitoring that addresses resource health is a critical gap in community-based management. The purpose of this project was to develop a community-driven monitoring program in Hāʻena, Kauaʻi. I used a Community-based Participatory Research approach of mixed methods such as focus groups, coastal monitoring, and seasonal observations. The results of this project offer a process in a holistic understanding of resource health, integration of knowledge systems, building relationships and community collaboration towards *ʻāina momona*, a thriving people and place.

Felipe Carvalho

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Using diagnostic tests to identify model misspecification in integrated stock assessments

Felipe Carvalho[1], Maia Kapur[2]

The complexity of stock assessment models is rapidly increasing. The advantages of integrated assessments are numerous and include the ability to combine many data sources to estimate important population dynamics processes. However, simultaneously analyzing multiple data sources can lead to conflicts among the data sources, especially between size-composition data and indices of relative abundance. Conflicts among data sets, which are often a symptom of model misspecification and evident as model mis-fit, can affect the estimates of important parameters and derived quantities. Diagnostic tests that identify misfit to data or which data components are in conflict can be used as starting places to identify the potential misspecification. Some of the most common or recently proposed diagnostic tests to be used with integrated stock assessments include likelihood profiling, residual analysis, age-structured production model diagnostic, and retrospective analysis. Most of the billfish and pelagic shark stock assessments to date in the North Pacific Ocean have relied on integrated models using Stock Synthesis. In this presentation we will show how the use of diagnostic tests to detect model misspecification assisted the improvement of these assessments. Further, we will provide an overview of existing tools readily available online to conduct diagnostic tests in integrated stock assessments.

Robert Dunn

San Diego State University and U.C. Davis
Advisors: Kevin Hovel and Marissa Baskett
NMFS Mentor: Stephan Munch
Population and Ecosystem Dynamics, 2016

Experiments reveal limited top-down control of key herbivores in southern California kelp forests

Robert Dunn, Kevin Hovel, Marissa Baskett

Predator responses to gradients in prey density have important implications for population regulation and are a potential structuring force for subtidal marine communities, particularly on rocky reefs where herbivorous sea urchins can drive community state shifts. On rocky reefs in southern California where predatory sea otters have been extirpated, top-down control of sea urchins by alternative predators has been hypothesized but rarely tested experimentally. In laboratory feeding assays, predatory spiny lobsters (*Panulirus interruptus*) demonstrated a saturating functional response to urchin prey, whereby urchin proportional mortality was inversely density-dependent. In field experiments on rocky reefs near San Diego, California, predators (primarily the labrid fish California sheephead, *Semicossyphus pulcher*) inflicted highly variable mortality on purple urchin (*Strongylocentrotus purpuratus*) prey across all density levels. However, at low to moderate densities commonly observed within kelp forests, purple urchin mortality increased to a peak at a density of ~11 urchins/m2. Above that level, at densities typical of urchin barrens, purple urchin mortality was density-independent. When larger red urchins (*Mesocentrotus franciscanus*) were offered to predators simultaneously with purple urchins, mortality was density-independent. Underwater videography revealed a positive relationship between purple urchin density and both the number and richness of fish predators, but these correlations were not observed when red urchins were present. Our results demonstrate highly variable mortality rates across prey densities in this system and suggest that top-down control of urchins can occur only under limited circumstances. Our findings provide insight into the dynamics of alternate community states observed on rocky reefs and the complex effects of multi-trophic level fisheries.

Gabriel Englander

University of California, Berkeley
Advisor: Peter Berck
NMFS Mentor: Dale Squires
Marine Resource Economics, 2018

Property rights lead to protection of global marine resources

Gabriel Englander

Managing global marine resources by assigning property rights could align economic and conservation incentives, but only if unauthorized resource use is deterred. We evaluate whether Exclusive Economic Zones (EEZs), the primary international property rights regime for managing marine resources, deter unauthorized fishing. Using global, high resolution fishing effort datasets and the ecologically arbitrary boundary between EEZs and the high seas, we find that EEZs reduce unauthorized foreign fishing effort by 81% globally. Consistent with the high cost of patrolling EEZ boundaries, this deterrence effect is concentrated in EEZs that are most valuable near their boundaries. Our results suggest property rights can enable effective governance of global marine resource use.

Adam Hayes

University of Washington
Advisor: David Layton
NMFS Mentor: Alan Haynie
Marine Resource Economics, 2017

Network Analysis of Halibut and Sablefish Quota Trading

Adam Hayes, Alan Haynie

Catch shares are a common policy instrument to mitigate the common pool resource problem associated with fisheries while avoiding perverse incentives that lead to overcapitalization of fishing fleets. A key feature of many catch share programs is that holders of quota can transfer their catch share rights, either temporarily or permanently. Previous research has noted that participation in a fishery tends to decline after a catch share system is implemented and catch share transfer prices tend to converge over time within the fishery. Here I focus on the Pacific halibut fishery which became a catch share fishery beginning in 1995. As of 2015, the number of quota holders has indeed declined by 56% compared to the initial allocation in 1995. Using data on halibut catch share trading in Alaska for the years 2000-2016, I model price dispersion and quota trading behavior over time using a network analysis approach to account for the non-independence of trades within the network. I explore the degree to which buyers and sellers remain segmented over time and the affect this segmentation has on price dispersion in the catch share market. I use this model to estimate the relationship between total allowable catch levels in each IFQ area and the corresponding prices and fishery participation decisions.

Justin Hospital

NOAA Pacific Islands Fisheries Science Center

Fisheries Economics in the Pacific Islands Region

Justin Hospital

PIFSC researchers conduct a broad range of economics research across the Pacific Islands Region to support NOAA goals of sustainable fisheries, habitat conservation, and protected species recovery within coastal and oceanic ecosystems. By integrating social and economic aspects of communities, we can manage fisheries and protected species in a way that works best for everyone. Economic and socio-cultural analyses helps managers evaluate the benefits and costs of different activities, prioritize needs, and encourage policies that maximize societal benefits from ocean and coastal resources. This presentation will provide an overview of the fisheries economics portfolio at PIFSC, including support for regional fisheries management, efforts to advance ecosystem science and future directions.

Joseph Langan

University of Rhode Island
Advisor: Jeremy Collie
NMFS Mentor: Christopher Legault
Population and Ecosystem Dynamics, 2018

A Bayesian State-Space Approach to Improve Projections of Stock Biomass for Managing New England Groundfish

Joseph Langan, Christopher Legault, Gavino Puggioni, Jason McNamee, Jeremy Collie

Specification of Allowable Biological Catch requires projecting biomass one to three or more years beyond the terminal year of fish stock assessments. However, these projections are often highly uncertain and can perform poorly under retrospective review. For many New England groundfish stocks, consistent biases in assessments, known as retrospective errors, have led to overestimation of biomass resulting in unintentional overfishing, sharp reductions in catch quotas, and decreased stakeholder confidence in the management process. In an effort to address such issues, this work will develop a Bayesian state-space model aimed at improving projections of fish stock abundance. The approach will allow for the inclusion of climate data, expert input (e.g. use of estimates of biological parameters from the literature as prior information), and inference from similar species, where appropriate, to make full use of all data available to inform stock projections. The performance of the developed modeling framework, compared with existing approaches, will be evaluated both in simulation and through retrospective forecasting of assessment data for three data-rich and three data-limited New England groundfish stocks by calculating the prediction-error variance (based on the difference between the realized and projected biomass). The results will then be openly shared with assessment scientists through the development of an R package to implement the proposed modeling strategy such that it can be applied broadly in the management of marine fisheries.

Jason Link

Senior Scientist for Ecosystem Management, NOAA-NMFS, Woods Hole, MA

Are there common, fundamental, emergent properties of all marine ecosystems, and if so are they useful?

Jason Link

Whether there are common and emergent patterns from marine ecosystems remains an important question because marine ecosystems provide billions of dollars of ecosystem services to the global community, but face many perturbations with significant consequences. Here, we develop cumulative trophic patterns for marine ecosystems, featuring sigmoidal cumulative biomass (cumB)–trophic level (TL) and 'hockey-stick' production (cumP)–cumB curves. The patterns have a trophodynamic theoretical basis and capitalize on emergent, fundamental, and invariant features of marine ecosystems. These patterns have strong global support, being observed in over 120 marine ecosystems. Parameters from these curves elucidate the direction and magnitude of marine ecosystem perturbation or recovery; if biomass and productivity can be monitored effectively over time, such relations may prove to be broadly useful. Curve parameters are proposed as possible ecosystem thresholds, perhaps to better manage the marine ecosystems of the world.

Natalie Lowell

University of Washington
Advisor: Lorenz Hauser
NMFS Mentors: Eric Ward and Robin Waples
Population and Ecosystem Dynamics, 2017

Genetic risk assessment of native shellfish aquaculture: preliminary results

Natalie Lowell, Eric Ward, Brent Vadopalas, Bobbi Hudson, Benoit Eudeline, Bob Sizemore, Lorenz Hauser

Shellfish growers are interested in cultivating native shellfish species because introduction of non-native species for aquaculture is severely restricted or prohibited. However, aquaculture of native species poses genetic risks to wild populations if farmed and wild individuals interbreed. These genetic risks include loss of fitness due to domestication selection, and loss of genetic diversity within and among populations. We aim to quantify these genetic risks using an individual-based simulation model of shellfish production. The model simulates wild broodstock collection, production of seed, planting of seed on a farm, and interbreeding with wild conspecifics. Response variables, including absolute fitness, FST, and Ne per population will be used to measure the genetic impacts on wild populations. Ultimately, we will use the model in a management strategy evaluation to compare the risks of status quo shellfish production to feasible alternatives. We gathered input from shellfish growers to ensure that model construction and parameterization reflect current shellfish production practices. Additionally, we gathered input from shellfish resource managers and shellfish growers to define management strategies that are feasible to stakeholders and relevant to the management context. Here, we present stakeholder input results and preliminary simulation results. Our study will provide an important synthesis of these risks as well as management recommendations for decision makers in the shellfish aquaculture industry.

Mackenzie Mazur

University of Maine
Advisors: Teresa Johnson, Yong Chen
NMFS Mentor: Burton Shank
Population and Ecosystem Dynamics, 2018

Developing a management strategy evaluation framework for the Maine lobster fishery in a changing Gulf of Maine

Mackenzie Mazur, Teresa Johnson, Yong Chen

Management strategy evaluation (MSE) is an emerging approach used to inform decision-making in fisheries management. MSE includes choosing management objectives, identifying measures of performance, identifying alternative management strategies, and using simulations to evaluate these management strategies. However, MSE has not yet been developed for the valuable and rapidly changing Gulf of Maine (GOM) American lobster fishery. The goal of this research is to integrate quantitative fisheries modeling and social science to develop a MSE framework that will be used for evaluating alternative management strategies in a changing GOM and to provide critical management advice for the development of a resilient fishery. The American lobster population and fishery are changing rapidly, and it is unclear what will happen to the population and fishery in the future. Social science can provide new insight into the uncertainties of the fishery by integrating harvester knowledge into decision-making. In this study, we used semi-structured interviews, oral history interviews, and surveys to identify uncertainties regarding both fishing behavior and recruitment dynamics and incorporated these into an individual-based lobster simulator. The simulator is then used to evaluate different management strategies. This study will provide a platform to answer “what-if” questions in the Maine lobster fishery management and inform the lobster industry and management agencies of possible consequences of changes in management strategies in a changing GOM.

Richard Methot

NOAA Fisheries Senior Scientist for Stock Assessments

Advancements and challenges in the stock assessment enterprise

Richard Methot

The U.S. stock assessment enterprise is advancing on numerous fronts to provide better advice for fish stock status determinations and fishery catch quotas. Some advances focus on the population model performance. Others expand the scope of the investigations to link the population models to climate and ecosystem processes. A third category involves efforts to improve data collection and analysis. As we begin to implement the updated Stock Assessment Improvement Plan, we intend to build a strong assessment research enterprise to advance these many factors, and to provide a pathway for moving these advancements into the operational assessment models used for management advice. Here I will provide two assessment stories. One will be advances and challenges in the modeling of spatial structure in populations. The other will be development of methods to quantify the performance of optical surveys for reef fish.

Elizabeth Ng

University of Washington
Advisor: Timothy Essington
NMFS Mentors: Jonathan Deroba
Population and Ecosystem Dynamics, 2017

Do predator diets track prey abundance?

Elizabeth Ng, Jonathan Deroba, Timothy Essington, Arnaud Grüss, Brian Smith, James Thorson

Predator stomach contents contain information about prey species but can vary widely in space and time. Previous work on predators of Atlantic herring showed that an index of herring abundance developed from stomach content data tracked assessment-estimated herring abundance but depended primarily on which predators were included in the index. Furthermore, uncertainty for the index was difficult to quantify due to the complicated survey sampling design. We build on this previous work and use spatiotemporal models to evaluate the relationship between predator diet composition and relative abundance of Atlantic herring. Using fishery independent survey data and quantitative stomach content data collected from 1973 to 2015 from the Gulf of Maine/Georges Bank ecosystem in the Northwest Atlantic, we developed an index of herring abundance and estimate per capita consumption rates of herring. Accounting for spatiotemporal variability in stomach content data can help extract information about the predation landscape and prey population dynamics, providing information about ecosystem interactions that be used to improve management.

Kristen Omori

Virginia Institute of Marine Science
Advisor: John Hoenig
NMFS Mentors: Cindy Tribuzio
Population and Ecosystem Dynamics, 2018

Use of cluster analyses and ordination techniques to identify species complexes

Kristen Omori, Cindy Tribuzio, John Hoenig

Many governing international laws require all fished stocks to have harvest targets; this can be challenging for data-limited species. One popular approach to assess these species is to form and manage them as complexes. The species that comprise a complex should have similar life history, susceptibility to fishing gear and geographic distribution. However, forming complexes to meet these standards is difficult particularly for non-targeted species or multispecies fisheries. A combination of cluster analyses and ordination techniques (e.g., nonmetric multi-dimensional scaling and canonical correspondence analysis) is applied to the datasets to develop appropriate complexes for twenty-five rockfish species (Sebastes spp.) in the Gulf of Alaska. Aggregating species based exclusively on either life history or fishery relations can lead to unsuitable groupings. Thus, multiple datasets including life history characteristics, two fishery independent surveys and commercial fisheries data are used in the analyses. Appropriate complexes are ones that are consistent with multiple methods.

Cassidy Peterson

College of William & Mary, Virginia Institute of Marine Science
Advisor: Robert Latour
NMFS Mentor: Enric Cortés
Population and Ecosystem Dynamics, 2017

Treatment of conflicting survey indices

Cassidy Peterson, Dean Courtney, Robert Latour

Comprehensive trends in abundance are common data requirements for many stock assessment models and are ideally calculated using fishery-independent surveys. For spatially wide-ranging species with slow-growing life histories and complex life cycles, comprehensive population-wide surveys are unrealistic, such that assessments must rely on several independent and spatially fragmented surveys to generate distinct indices of relative abundance. When compiled, despite sampling the same population, multiple survey-based indices of relative abundance frequently conflict with one another, hindering interpretation and assessment performance. Atlantic coastal shark species are ubiquitously afflicted with such assessment challenges. Dynamic factor analysis (DFA), a multivariate, dimension reduction technique, has been proposed to rectify conflicting indices of relative abundance by extracting latent trends from a collection of survey data. Two coastal shark populations along the US east coast, representing two management units, were simulated, fished, and surveyed using age-structured models. Conflicting indices were generated through relatively large index uncertainty and changing survey catchability. The simulated populations were used to explore the circumstances under which DFA adequately described underlying trends in abundance from conflicting indices of relative abundance. Simulated conflicting indices were then input into Stock Synthesis (SS3) assessment models, and compared to assessment results generated from using the reduced DFA trend as a single input of relative abundance. Preliminary results of DFA performance outside and within the stock assessment will be presented. The results of this study have the potential to impact operational protocols for shark stock assessments conducted within the United States.

Mikaela Provost

University of California, Davis
Advisor: Louis Botsford
NMFS Mentor: Michael O'Farrell
Population and Ecosystem Dynamics, 2016

Life history drivers of long and short-term variability in populations. A comparative analysis of North Atlantic cod *Gadus morhua* as an example

Mikaela Provost, Louis Botsford

Ecologists and managers have a long-standing interest in understanding the mechanisms that drive fish populations to fluctuate. A central tenet of population dynamics is determining the relative influences of endogenous factors such as species' life history and exogenous factors such as the role of the environment or fishing in contributing to the variability observed in populations. Here we view life history as a filter of environmental variability. We investigate variance in populations at both long and short time periods without the influence of harvest or climate change to understand the inherent variability associated with different life histories. To explore these questions, we focus on 16 North Atlantic cod Gadus morhua populations which vary in longevity and maturation age. We use stochastic age-structured models to describe the dynamics of cod populations and use spectral analysis to quantify variability in abundance and recruitment at different time periods. We show that variability over long time periods is determined by the population's position on the stock-recruit curve and variability over short time periods is determine by characteristics of spawning biomass over age distribution.

Molly Timmers

University of Hawaii
Advisor: Robert Toonen
NMFS Mentor: Felipe Carvalho
Population and Ecosystem Dynamics, 2018

Understanding and predicting population outbreaks of the destructive coral-eating crown-of-thorns sea star, *Acanthaster planci*, in the U.S. Pacific Islands

Molly Timmers, Felipe Carvalho, Kyle Edwards, Megan Donahue, Frank Parrish, Jeff Polovina, Rob Toonen

One of the most significant present-day threats to coral reefs in the Indo-Pacific is a population outbreak of the coral-eating crown-of-thorns sea star, *Acanthaster planci*. In low densities, crown-of-thorns have little impact on coral abundances. However, at high densities they are detrimental to the ecology and the economic value of coral reef ecosystems, jeopardizing reef resilience and recovery. To reduce the impact of these corallivores, costly control and eradication programs have been established as short-term solutions. Long-term solutions, however, require an improved understanding of *A. planci* distributions and the cause(s) of outbreaks. Using an unprecedented data set collected over a decade across 36 U.S. Pacific-affiliated islands and atolls, this project will model outbreak populations observed both temporally and spatially from standard survey techniques conducted across a large geographic range of disparate islands and atolls along anthropogenic and environmental gradients. The results from this work will enhance the scientific foundations needed to better understand outbreak patterns and distributions, and contribute to the NMFS priorities focused on managing and conserving ESA-listed coral species in the Pacific.

Robert Wildermuth

University of Massachusetts, Dartmouth
Advisor: Gavin Fay
NMFS Mentor: Sarah Gaichas
Population and Ecosystem Dynamics, 2018

Evaluation of a Bayesian decision network for ecosystem-based management of the Georges Bank social-ecological system

Robert Wildermuth, Gavin Fay, Sarah Gaichas, Geret DePiper

Fisheries on Georges Bank, USA, are affected by a number of environmental and human drivers and provide a multitude of benefits to New England coastal communities. Fisheries managers need decision tools capable of quickly integrating disparate datasets, accounting for uncertainties, and assessing tradeoffs between ecological, social, and economic objectives. Although quantitative assessment tools exist at single stock, multi-species, and whole-ecosystem scales, these models are difficult to fully evaluate for sensitivity to process, observation, and structural uncertainties. We developed a semi-quantitative Bayesian network model that integrates monitoring data and expert knowledge to estimate direct and indirect effects of multiple uses of living natural resources on Georges Bank. We described the predictive sensitivity of our model with respect to 12 management objectives and evaluated the model's predictive ability with hindcasts of a 58-year time series. Our results suggest that Bayesian network methods can provide tools to evaluate complex marine social-ecological systems, even when few data exist for some components of interest.

Megan Winton

University of Massachusetts, Dartmouth
Advisor: Gavin Fay
NMFS Mentor: Benjamin Galuardi
Population and Ecosystem Dynamics, 2017

Estimating individual- and population-level variation in the space use of white sharks off Cape Cod, Massachusetts, from passive acoustic telemetry data

Megan Winton, Gavin Fay, John Chisholm, Gregory Skomal

Spatial management practices for coastal shark species are often based on trends in space use inferred from data collected using passive acoustic telemetry arrays. Most acoustic telemetry studies seek to answer population-level questions related to occurrence and abundance but neglect the role individual variation in residency and site-fidelity may play in driving resulting estimates of space use and associations with environmental covariates. Here we develop a model to identify relationships between species occurrence and environmental covariates from acoustic telemetry data that directly accounts for differences in the spatial distribution of tagged individuals. The approach extends the generalized linear modeling framework often used to infer trends from acoustic telemetry data by accounting for individual heterogeneity using spatial random effects. We use simulation testing to compare the performance of the proposed models with spatial models that do not account for individual effects, as well as with non-spatial generalized linear modeling approaches most frequently used. We fit our models to acoustic detection data collected from tagged white sharks, *Carcharodon carcharias*, in the coastal waters off Cape Cod, Massachusetts, during the summer of 2015 and demonstrate how the models can be used to quantify the relationship between occurrence and environmental covariates and predict space use at both the individual- and population-level.